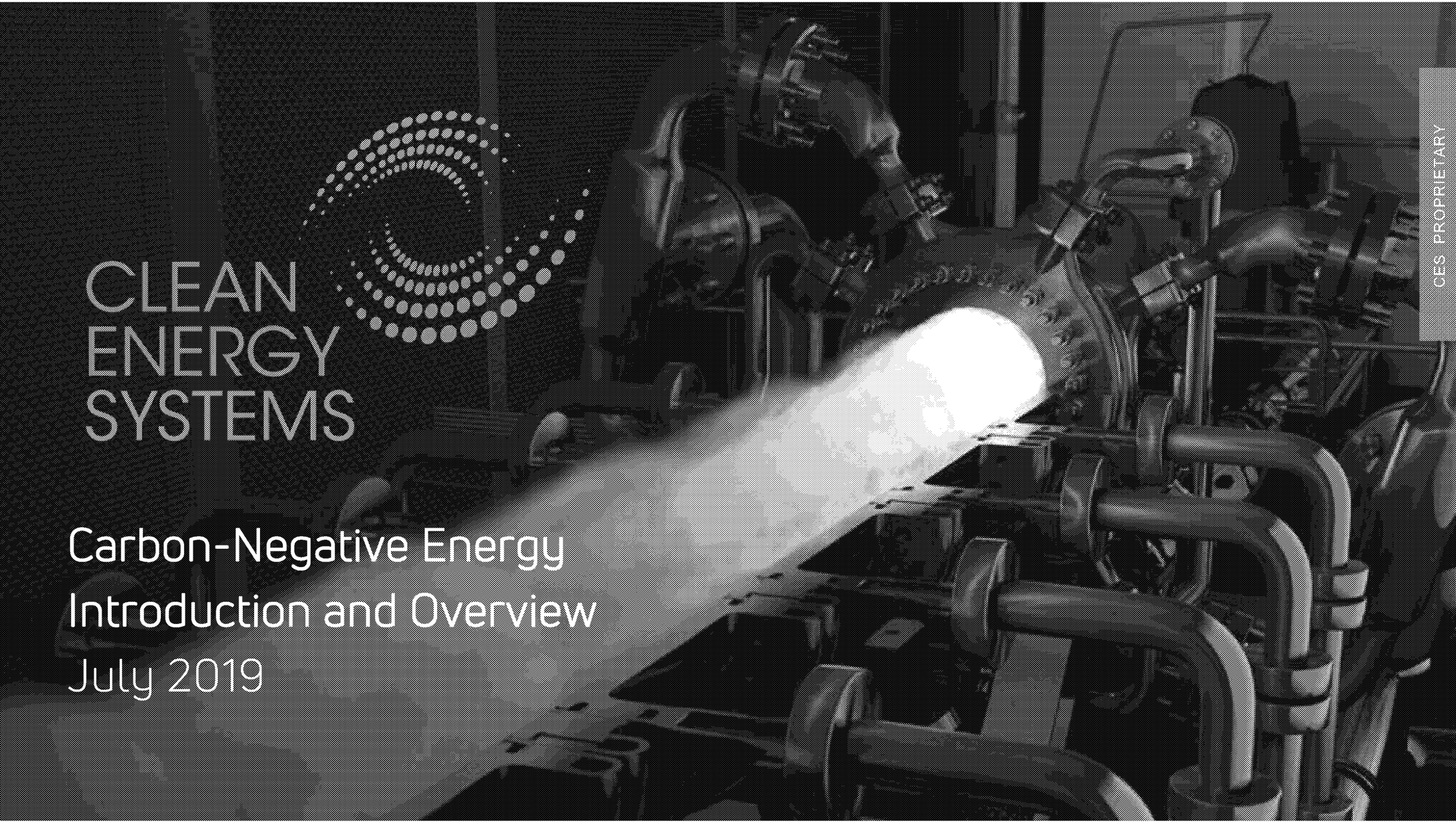


Carbon-Negative Energy
Introduction and Overview

July 2019

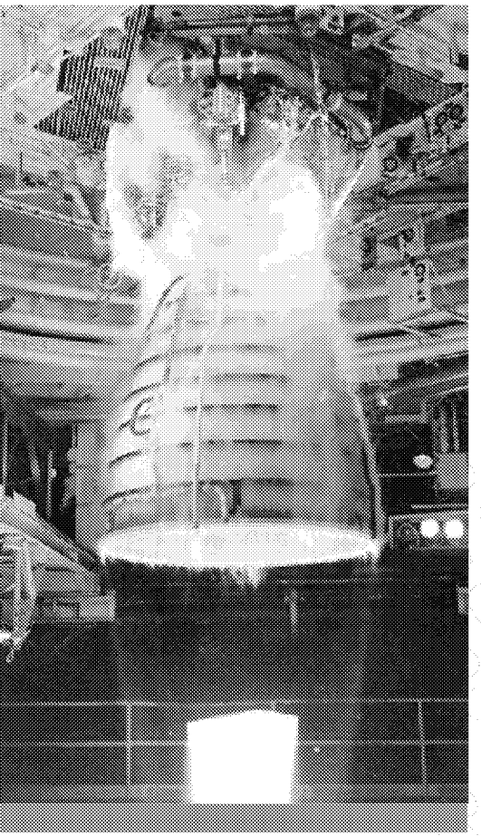
AGENDA

CLEAN ENERGY SYSTEMS

- Introduction to Clean Energy Systems
- Carbon-Negative Energy
  - What it is and Why we need it
  - How it works (including CES Technologies)
  - Potential projects
- Summary & Next Steps

CES | COMPANY BACKGROUND & OVERVIEW

CLEAN ENERGY SYSTEMS



- Founded in 1993 by former Aerojet (a GenCorp company) aerospace engineers; incorporated in 1996, Clean Energy Systems, Inc. (CES)
- Multiple locations in California:
  - Corporate Engineering and Headquarters, Rancho Cordova (Sacramento Area)
  - Kimberlina Test Facility (former 5 MWe Biomass Power Plant), Bakersfield
  - Placerita Power Plant (former 120 MWe CHP Plant), Santa Clarita
- Over 30 patents issued on zero-emissions oxy-combustion technologies and power cycles
- Focused on developing and deploying enabling technologies for advanced clean energy
  - Oxy-Fuel (O-F) Pressurized Direct and Indirect Steam Gas Generators and Reheat Combustors
  - Compact Diffusion Bonded Heat Exchangers
  - O-F Turbines (OFTs) with development partners

OUR VISION

Clean Energy Systems is the global leader in the development and deployment of carbon reducing energy systems

The Power to Reverse Climate Change

CES SOLUTIONS

Carbon Negative Energy (CNE)

Removes existing carbon from the atmosphere while producing renewable fuels and/or power

CES seeks to build a $1 B portfolio of carbon negative energy plants in California

California offers a unique combination of opportunities to deploy CNE

1. Robust carbon pricing and trading network
2. Enormous potential for onshore carbon storage
3. Excess of biomass wastes and idled resources
4. Strong government support and commitment to low carbon future
5. Process produces valuable water in drought prone agricultural zones

Carbon Reduction Solutions (CRS)

Reduces the amount of carbon released to the atmosphere from existing industrial processes

Accomplished through:

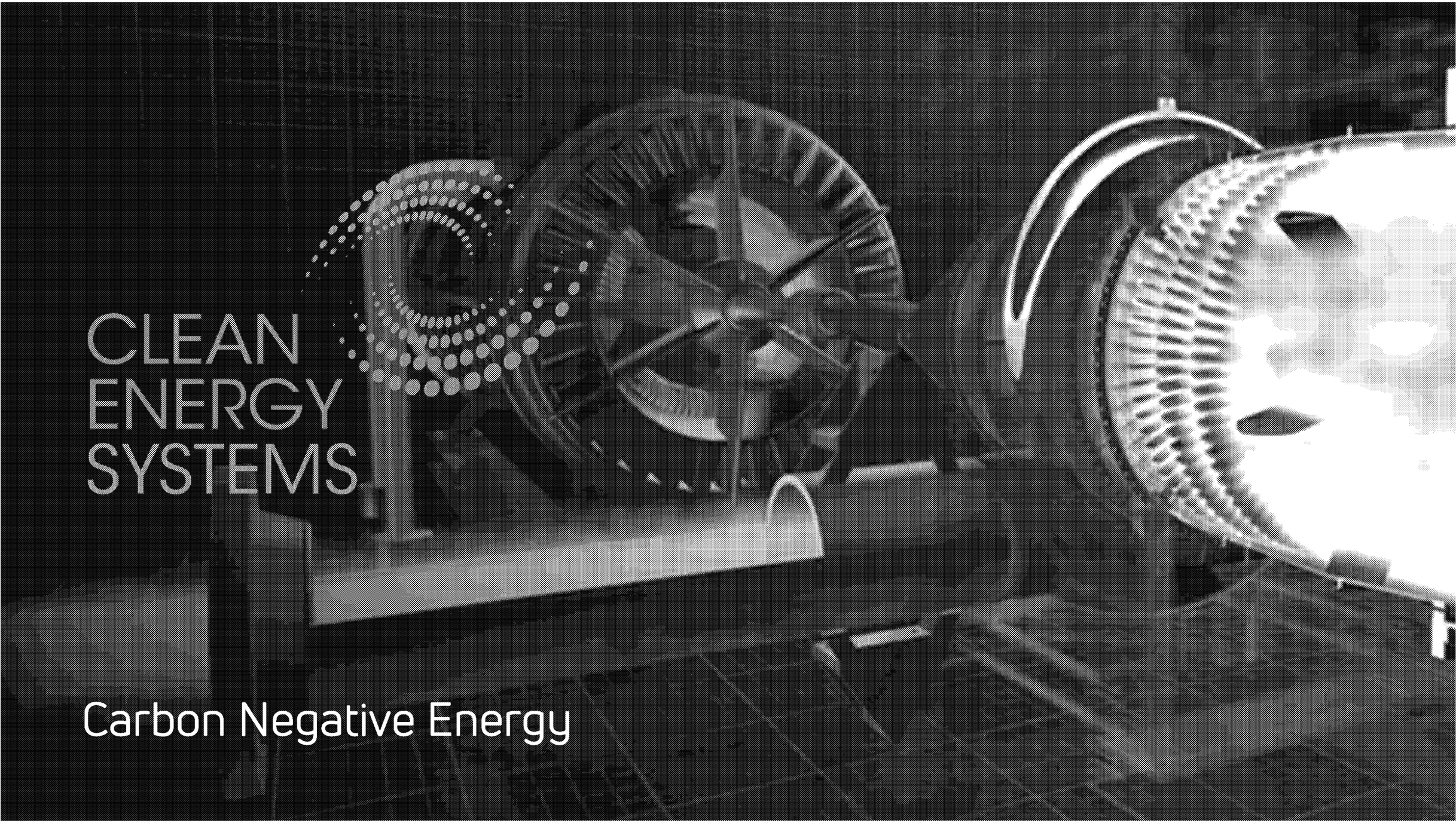
Clean Steam generation,

Compact Heat Exchange solutions to enable efficient renewable energy and clean power production,

Grid-Scale Energy Storage, and

Zero-Emissions Power production

In addition, CES offers engineering services and legacy aerospace work to drive technology advancements that can be incorporated into its products

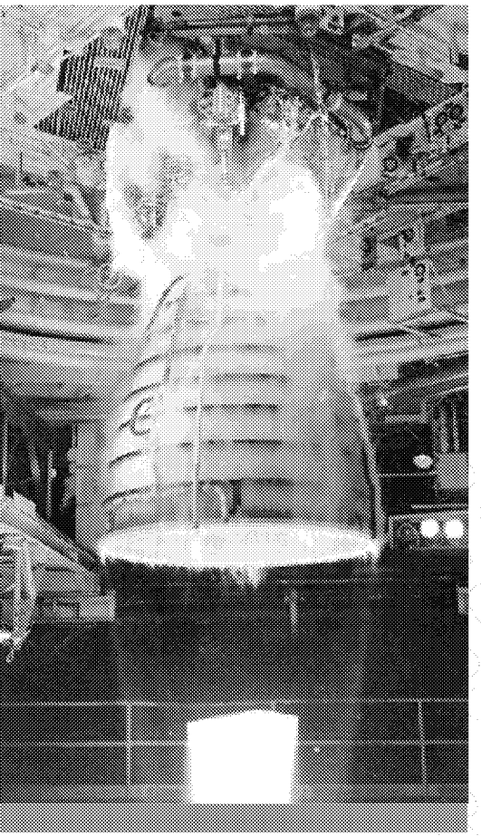

CLEAN
ENERGY
SYSTEMS
Carbon Negative Energy

CARBON NEGATIVE ENERGY | WHAT IS BioCCS?

CLEAN ENERGY SYSTEMS

- Carbon removal refers to any process or system capable of removing and sequestering carbon from the air over its life cycle
    - Enables clean up of emissions that have accumulated in the atmosphere
- BioCCS refers to any bioenergy process that captures and permanently stores carbon safely underground through carbon capture and storage (CCS)
    - Also known as BECCS (bioenergy with carbon capture and storage)
- There is a need for cost effective, scalable technologies that can be readily deployed in order to meet global climate goals
    - BioCCS systems hold vast potential to remove the harmful greenhouse gas carbon dioxide (CO_2) from the atmosphere while producing electricity and/or clean fuels

CNE I REVERSING CLIMATE CHANGE



- The world has set ambitious goals to limit global temperature rise to less than 2 deg. C to help stave off the detrimental effects of global climate change
- Societies across the globe are implementing strict, long-term policies to reduce green-house gas emissions including carbon taxes
- However, according to the UN's IPCC, we will fail to meet this target as greater than 100% emissions reduction is required

- In order to cease current global climate trends, we not only need to reduce carbon emissions, but **reverse** them
  - *The only solution is carbon-negative plants deployed on a grand scale*
  - *However there are no carbon negative energy plants operational today*

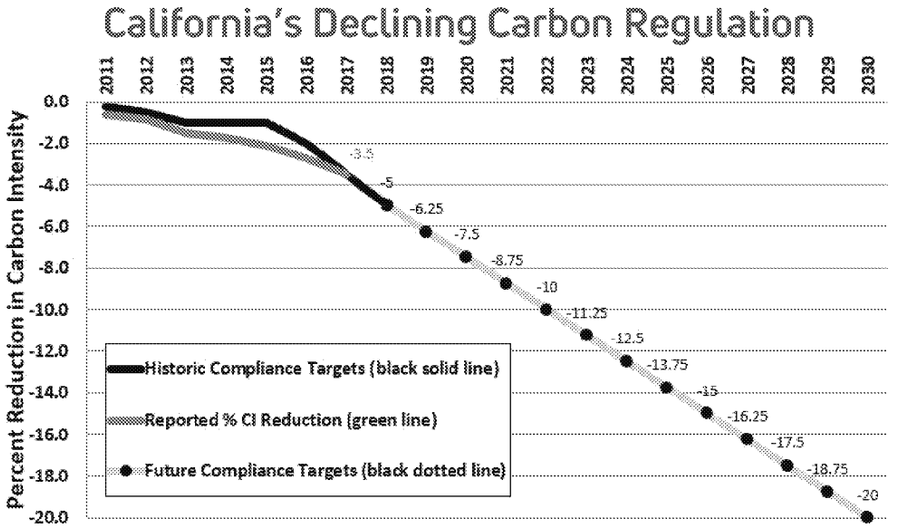
CES technology is available today based on 25 years of work and an investment in excess of $135 million

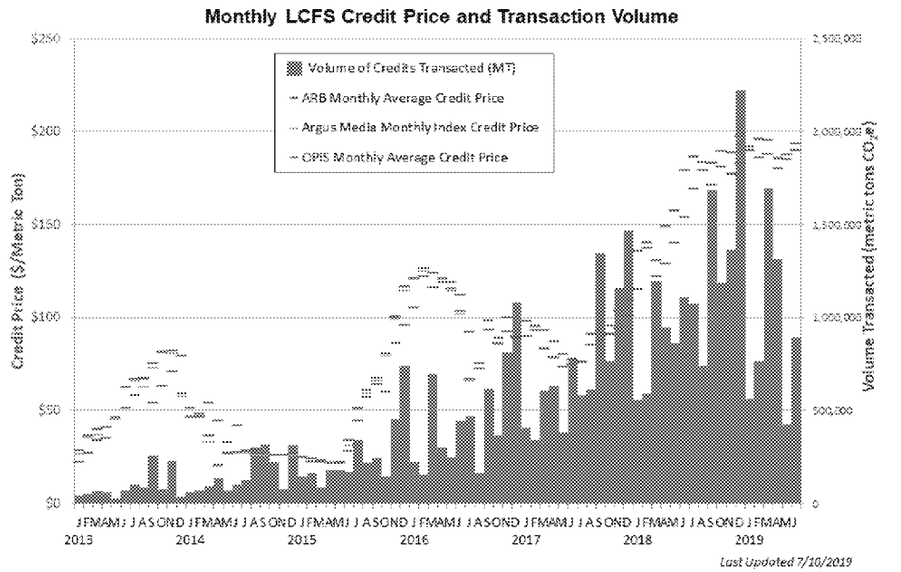
CNE | WHY NOW?

CLEAN ENERGY SYSTEMS

Multiple factors aligned to make deployment profitable

- Revenues for carbon capture and storage (CCS) have gone from $20/ton to $250/ton for select applications (e.g. CNE) in the past year
  - Federal Production Tax Credit increased from $20/ton of CO_2 sequestered to $50/ton in Feb-2018
  - California's LCFS program extended through 2030 and litigation resolved; obligations for transportation sector are "biting" with credit prices exceeding $180/ton and projected to increase near $215 cap
- At the same time, the biomass power industry in California has collapsed due to competition from wind and solar for new power contracts
  - Now stranded assets can only be used for alternative purposes
  - Feedstock pricing collapse; long-term fuel contracts available
- Enormous potential for CCS in California; projects build on knowledge gained from past efforts (e.g. WESTCARB)
- Required CES technology has been built and tested: No Technology Risk



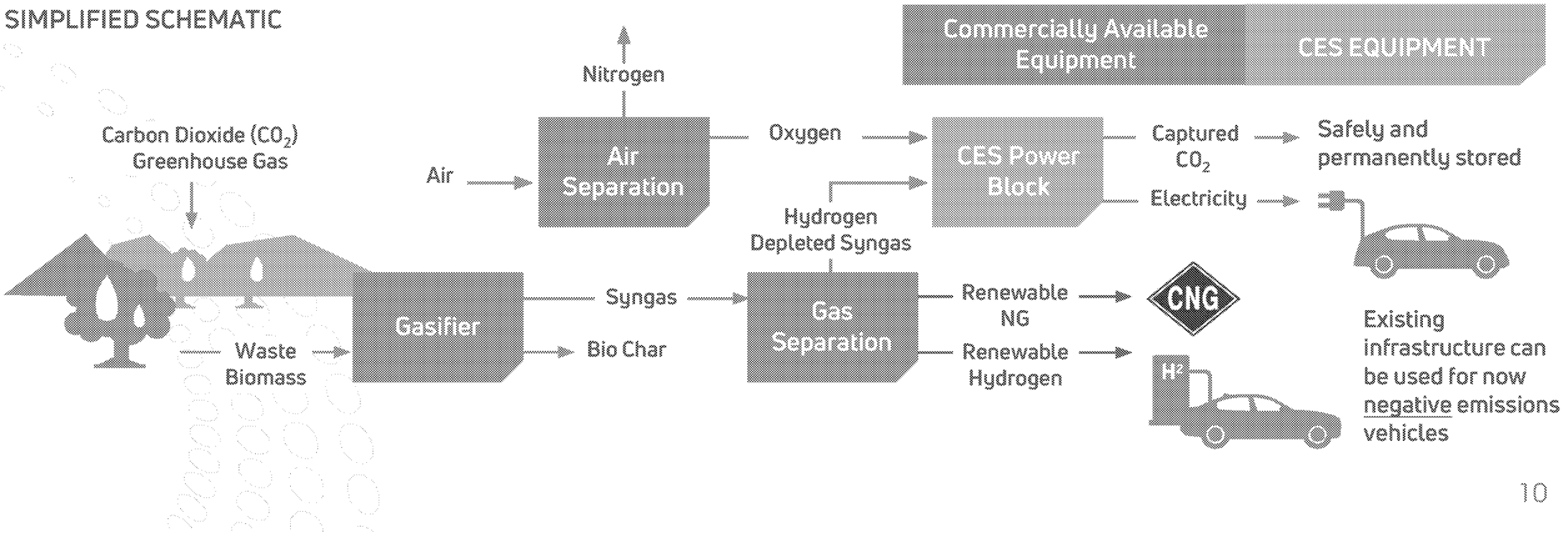


CNE | HOW IT WORKS

CLEAN ENERGY SYSTEMS

CES Carbon Negative Energy (CNE) plants use waste biomass fuels that are gasified to produce a synthesis gas. This "syngas" is then used to produce renewable natural gas (RNG), hydrogen (RH_2), and/or electricity with full carbon capture using CES proprietary oxy-combustion technology. By using fuel that consumes carbon over its lifetime (biomass) and safely and permanently storing all produced carbon dioxide (CO_2), the process results in net-negative carbon emissions, effectively removing harmful greenhouse gases from the atmosphere.

SIMPLIFIED SCHEMATIC



CNE I PROJECT OVERVIEW AND PLANT OPTIONS

Base Case CNE Plant

- 300 TPD biomass feedstock; Ag waste, forest management, RDF, MSW, etc.
  - 10-15 trucks per day
- Produces approx. 5,400 kg/day renewable hydrogen (RH_2)
  - Enough to fuel ~ 1,000 FCEVs
- Captures and permanently stores approx. 485 tonne/day of CO_2
  - Equivalent to removing over 31,500 passenger vehicles from the roads each year
- Electricity produced covers plant loads
- Repeatable and scalable

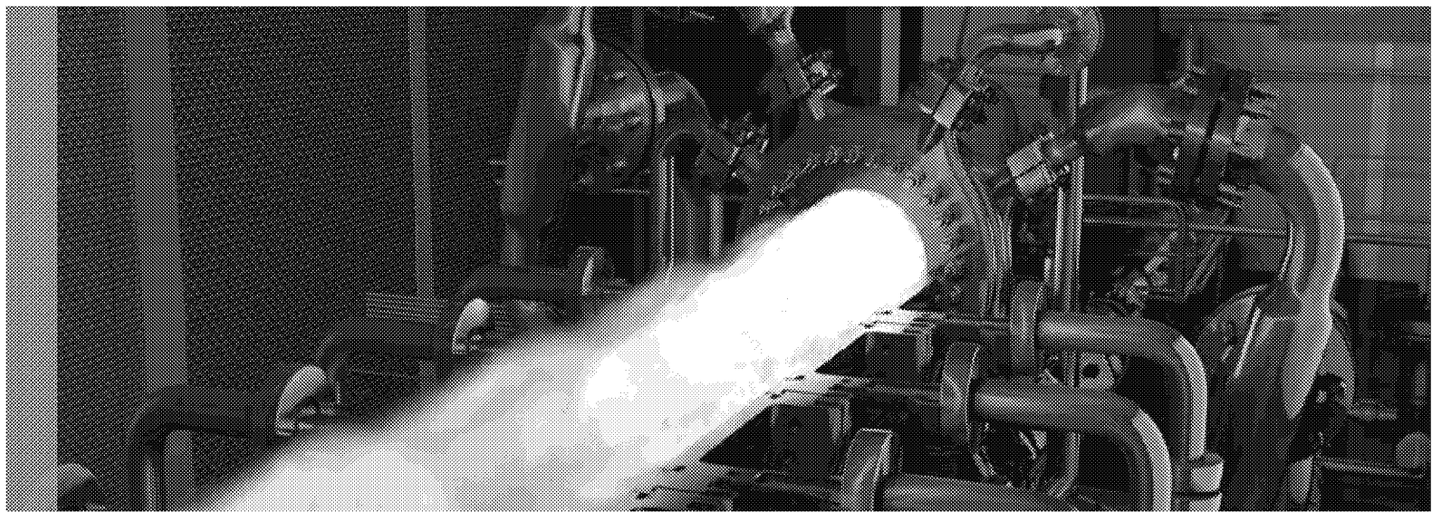
CNE Plant Options

- Ability to produce renewable natural gas (RNG) in place of, or in addition to RH_2
  - Up to approx. 3,200 MM BTU/day
  - However, reduces the total amount of CO_2 captured and stored
- Same plant can produce up to 6 MWe (net) renewable power
  - Same amount of CO_2 captured and stored but no longer produces other renewable fuels (RH_2, RNG)

CES ENABLING TECHNOLGY | PRESSURIZED OXY-COMBUSTION

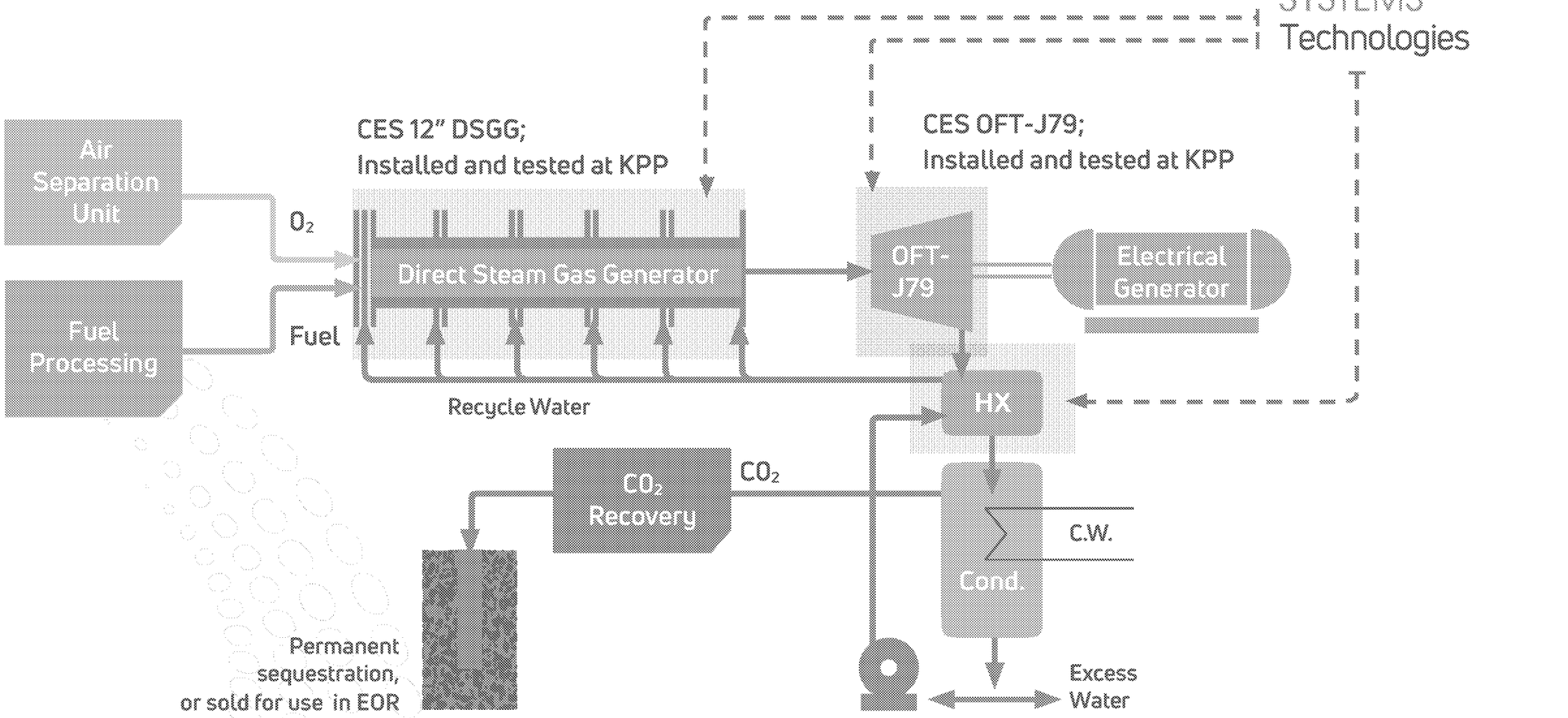
Derived from the American space program, CES combustion systems burn nearly pure oxygen (instead of air) with fuel such as natural gas, associated gas, syngas, high-CO_2 content natural gas, or liquid fuels, for a cleaner, more efficient combustion process

The intimate mixing of gases via unique IP creates combustion with only water (high pressure steam) and CO_2 as its two products which are easily separated for capture and storage



CES I POWER BLOCK

CLEAN ENERGY SYSTEMS Technologies

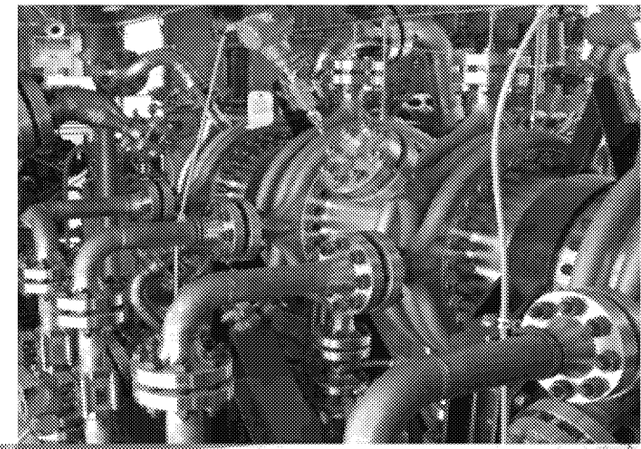


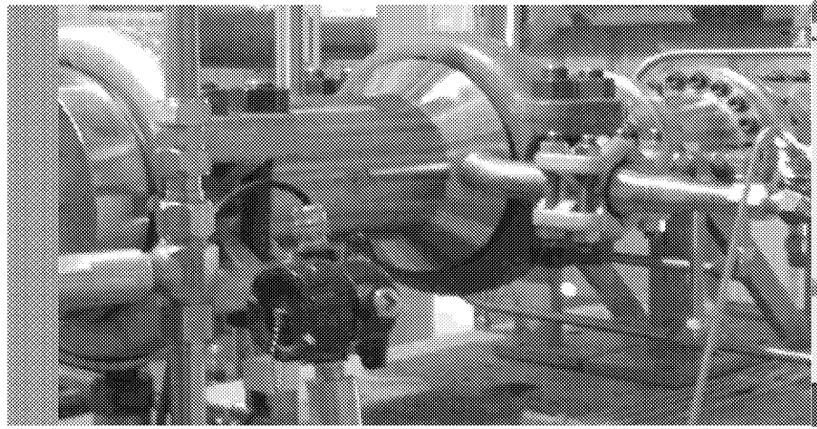
CES I DIRECT STEAM GAS GENERATORS

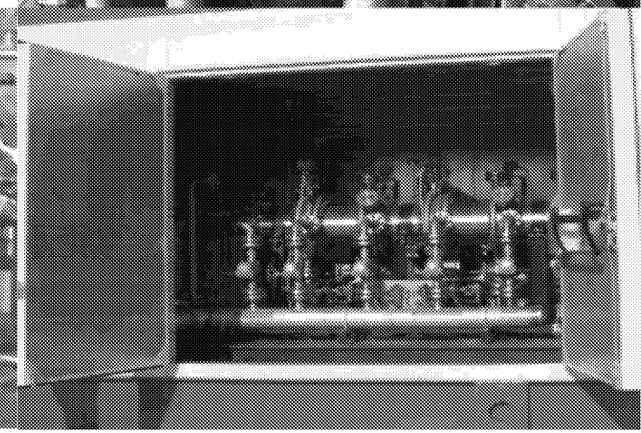
Compact system produces only steam and high purity CO_2 (when burning a hydrocarbon based fuel), and massive amounts of thermal energy

- Current designs with 10 cm (4 inch) or 30 cm (12 inch) internal diameters
- Range from 10 to 200 MWt delivering temperatures up to 1,650 °C (3,000 °F) and capable of pressures over 110 bar (1,600 psi)

- Water injection and jacket cooling incorporated for long life
- Standalone installation-Includes control and monitoring system
- Ramps to full power in seconds





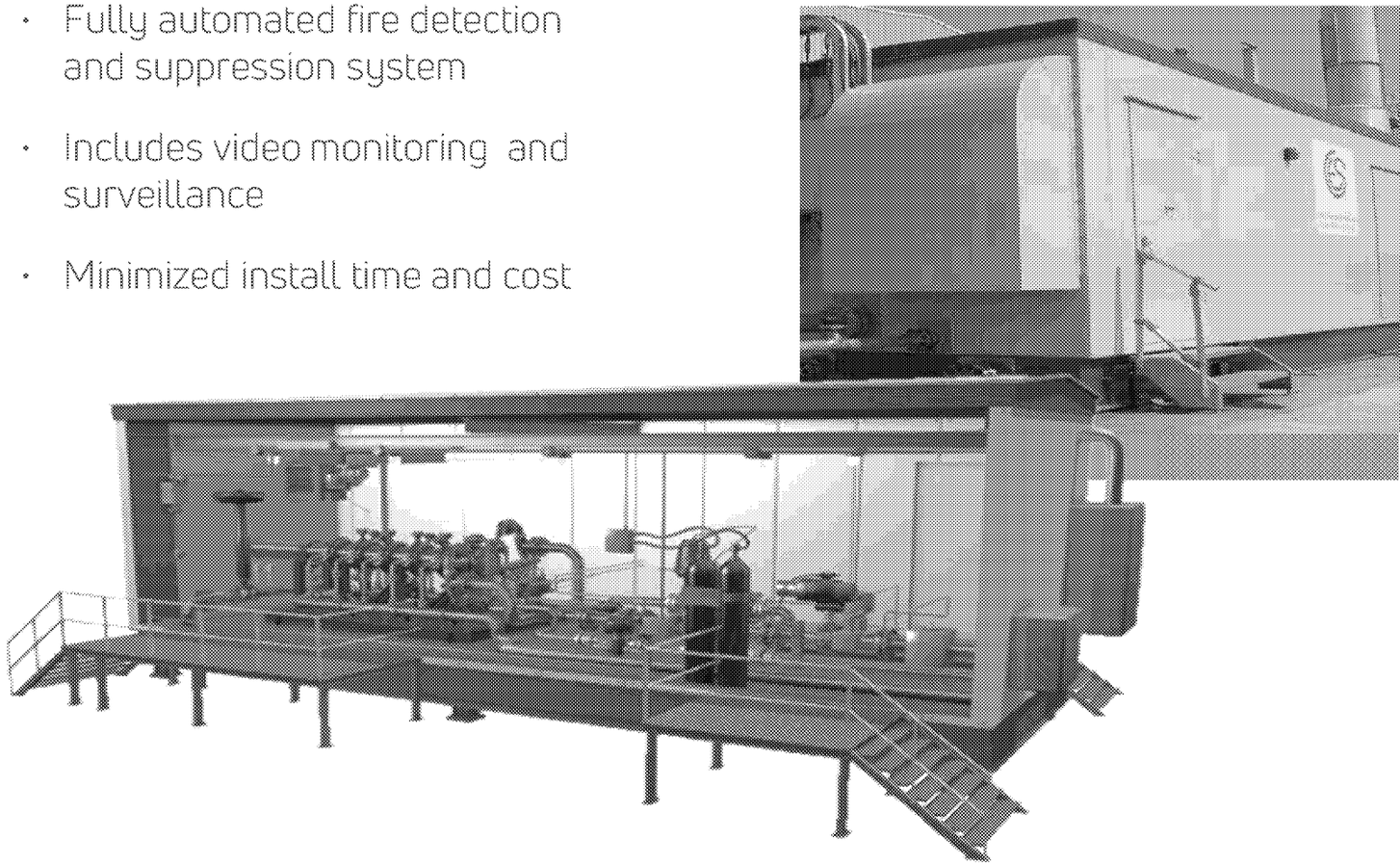


CES I DIRECT STEAM GAS GENERATOR PACKAGE

CLEAN ENERGY SYSTEMS

Fully containerized oxy-combustion system for easy transport and installation

- **Combustor:** 2 meters (6 feet) long with 30 cm (12 inch) internal diameter
- **Container:** 3.3 meters (11 feet) x 3.3 meters (11 feet) x 12 meters (40 feet)
- Fits on standard shipping vehicles
- Designed and built to ASME Section VIII, Division 1
- Fully automated fire detection and suppression system
- Includes video monitoring and surveillance
- Minimized install time and cost



CES | OXY-FUEL TURBINES

With development partners, turbines designed for high-quality steam and high CO_2-content drive gas

- Currently two turbines retrofit; modified for pressurized steam/CO_2 gas
- Removed front-end compressor section and replaced with steam/CO_2 inlet and thrust balance system
- Operate at gas turbine conditions

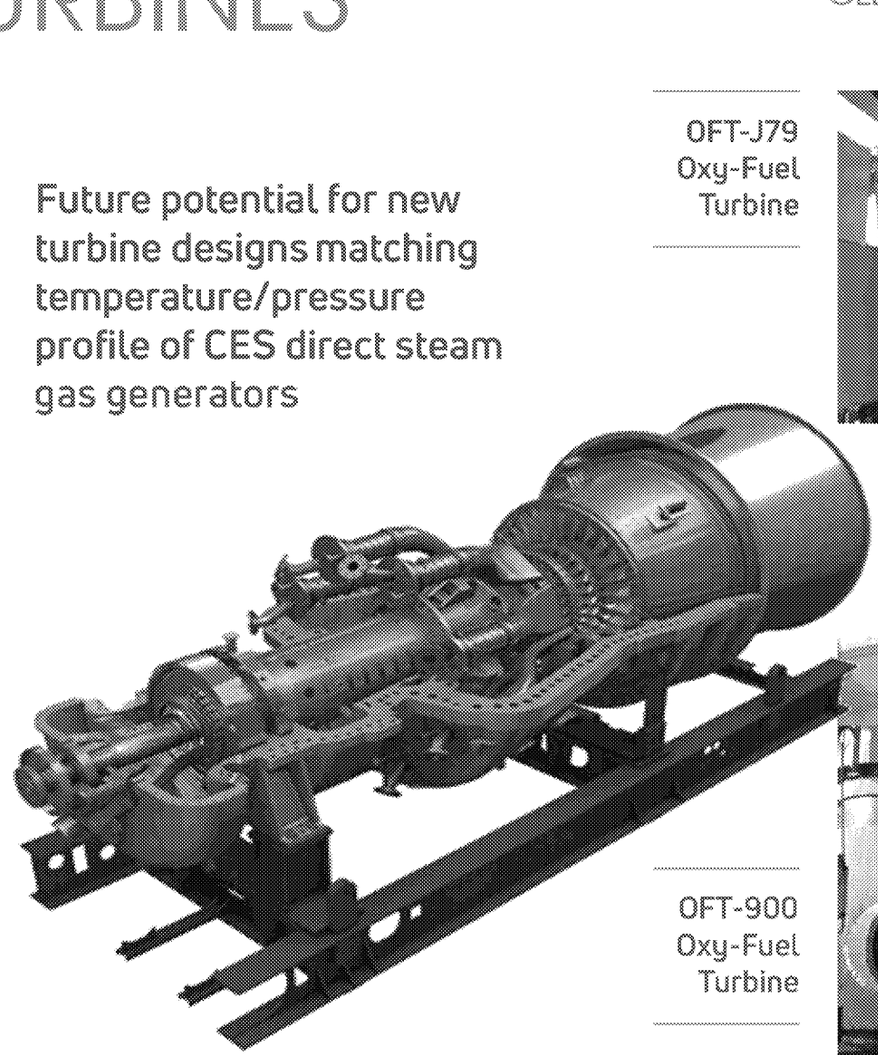
GE J79 retrofit to OFT-J79

- Up to 43 MWe from 12 MWe baseline

SGT-900 (W251 B12) retrofit to OFT-900

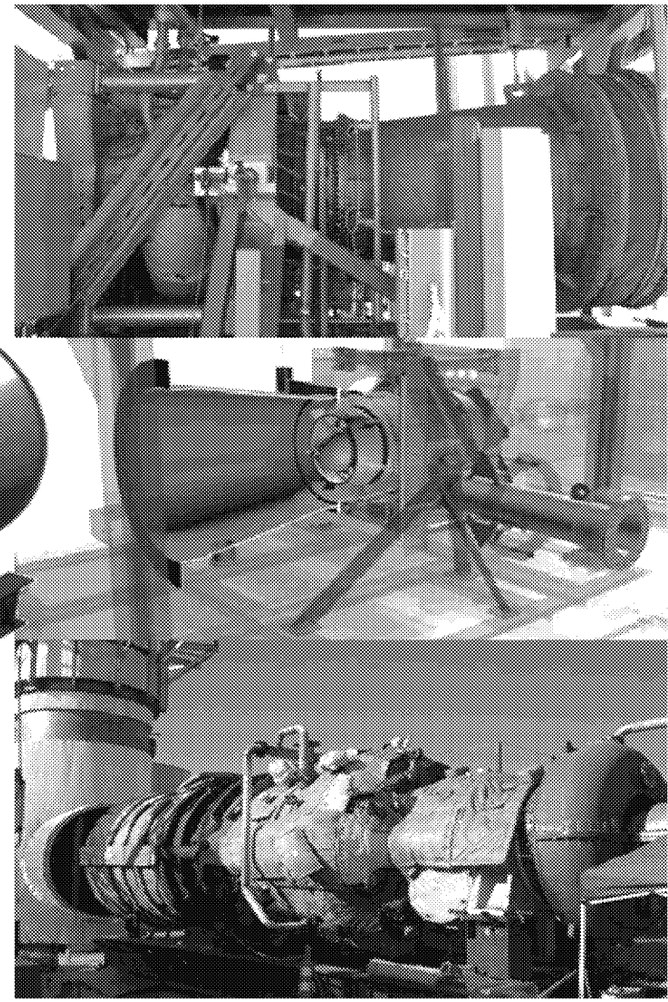
- Up to 150 MWe from 43 MWe baseline
- Makes use of CES reheat combustors
- CES, FTT, and Siemens design

Future potential for new turbine designs matching temperature/pressure profile of CES direct steam gas generators



With development partners

OFT-J79 Oxy-Fuel Turbine



OFT-900 Oxy-Fuel Turbine

CES | COMPACT HEAT EXCHANGERS

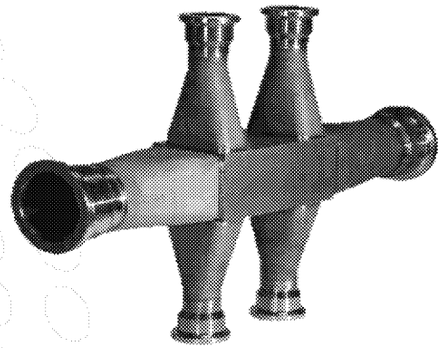
CLEAN ENERGY SYSTEMS

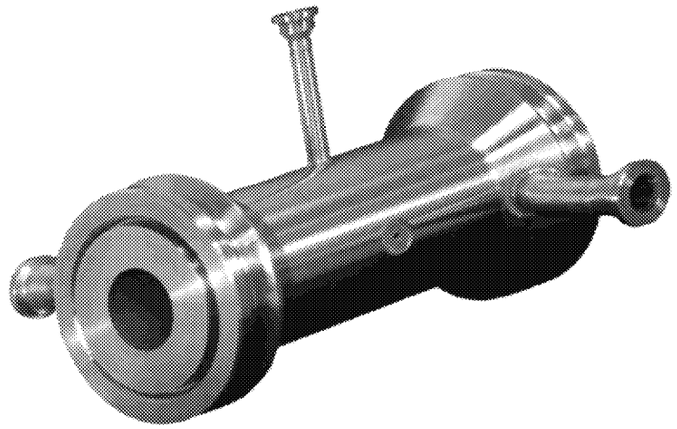
HEXCES

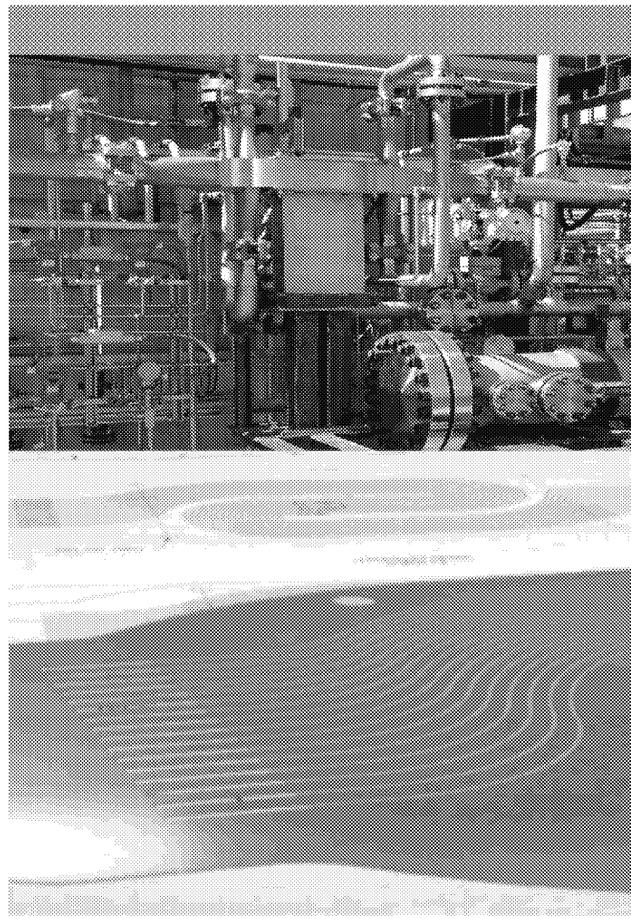
COMPACT PLATELET HEAT EXCHANGERS (CPHX)

Diffusion bonded heat exchangers enable next generation power systems and thermal energy storage (e.g. concentrating solar power)

- Capable of handling extreme operating temperatures (-200 to 900 °C) and pressures (600+ bar)
- 4 to 6 times smaller and lighter than conventional exchangers
- Unparalleled thermal effectiveness
- Unique designs can take any shape or size



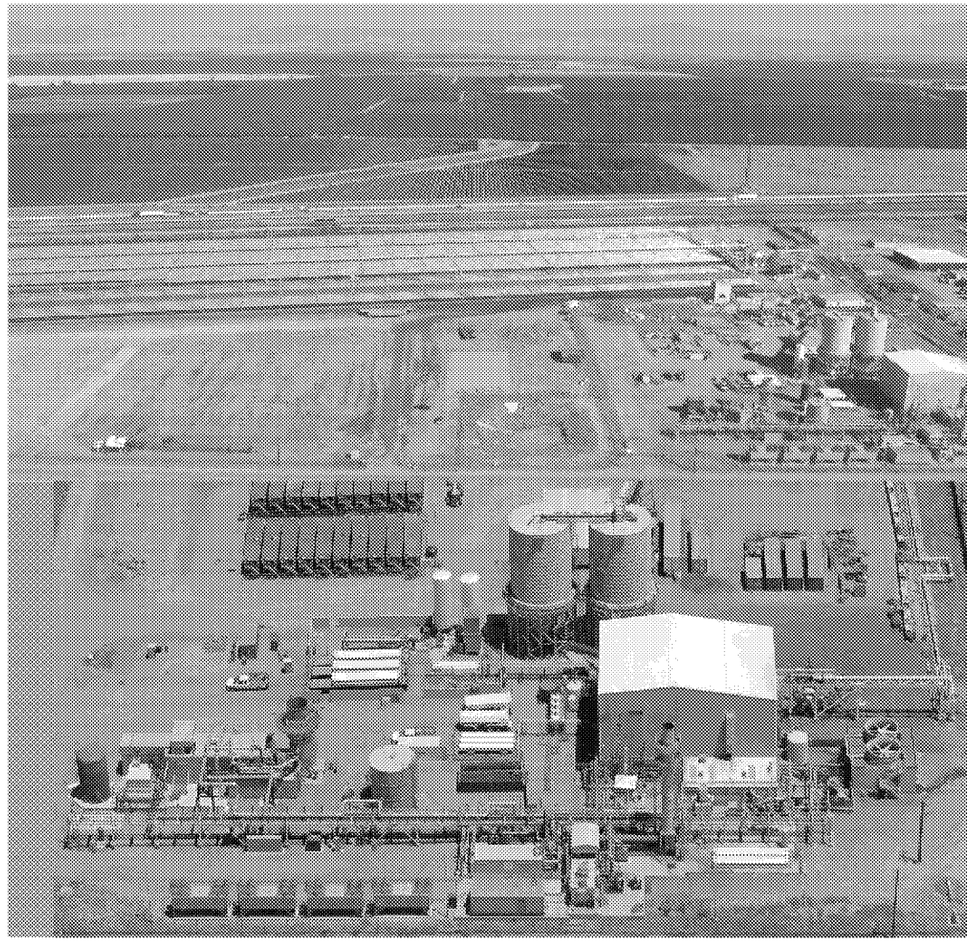




CNE I PROJECT #1
KIMBERLINA

CES' Kimberlina Power Plant

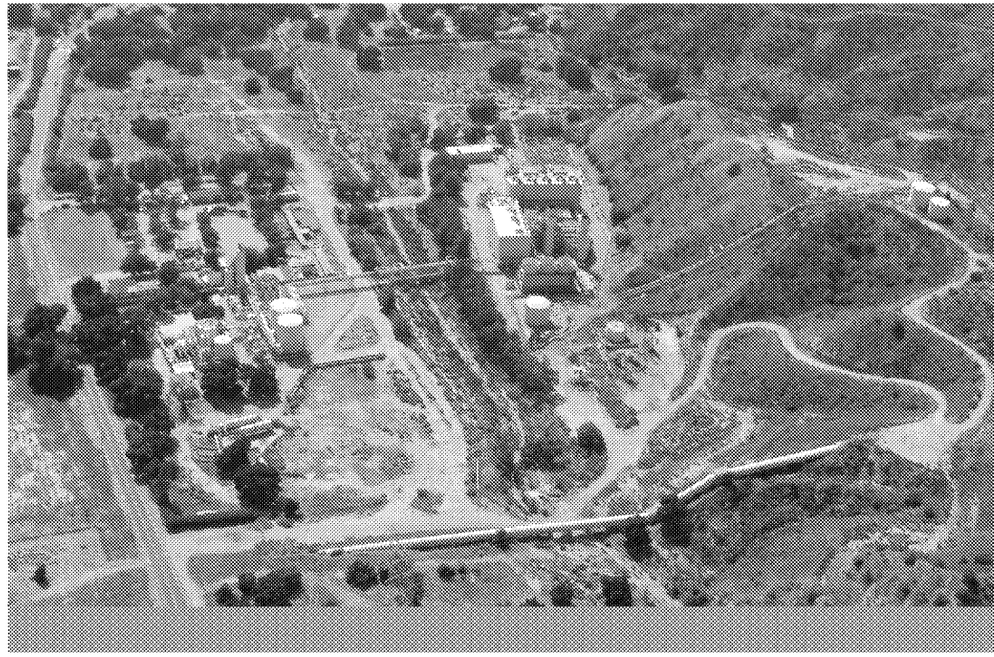
- Located in the heart of the California's Central Valley
  - Surrounded by fruit and nut orchards
  - Sitting on top of a WESTCARB identified CO_2 storage site, and between heavy and light oil fields in need of steam and CO_2
- Currently home to CES' commercial and test equipment
  - World's largest pressurized O-F combustion test facility
- RH_2 to be produced and sold into transportation section, through California refineries to reduce the carbon intensity of existing fuels
- Currently idled 300 TPD biomass plant; requires installation of biomass gasifier, oxygen supply (ASU), and RH_2 separation systems
- CO_2 to be sequestered on-site
  - Alternate option: CO_2 sales to nearby oil producers



CNE I PROJECT #2
PLACERITA

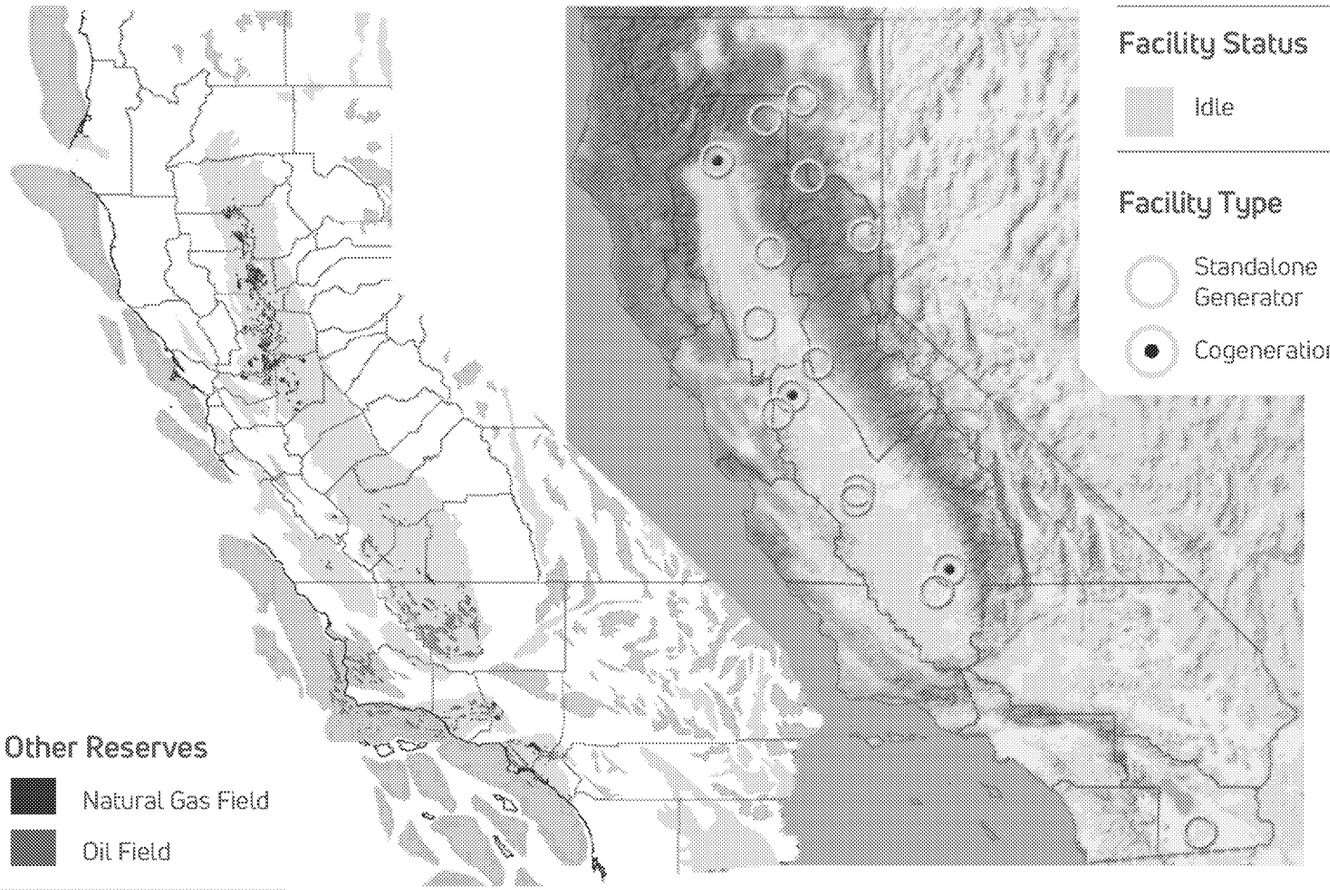
CES' Placerita Power Plant

- Former 120 MWe combined heat and power plant offers substantial infrastructure, making repower option attractive
- RH_2 to be produced and sold into transportation section, through California refineries to reduce the carbon intensity of existing fuels
- Requires installation of new biomass handling and gasifier systems, oxygen supply (ASU), RH_2 separation system and CES power block
- CO_2 storage not available on-site; CO_2 piped to nearby storage sites for permanent storage or for use in enhanced oil recovery
- Alternate option RNG production and/or energy storage to serve the greater Los Angeles area



CNE I POTENTIAL PROJECTS ACROSS CALIFORNIA

- At least 15 idle biomass power plants in California today (>375 MW), with more anticipated to close in the coming years
- A comparison of idle biomass facilities to California's sedimentary basins shows excellent potential for carbon capture and storage and possible use in enhanced oil or gas recovery (EOR/EGR)
- Several benefits of retrofit deployment strategy

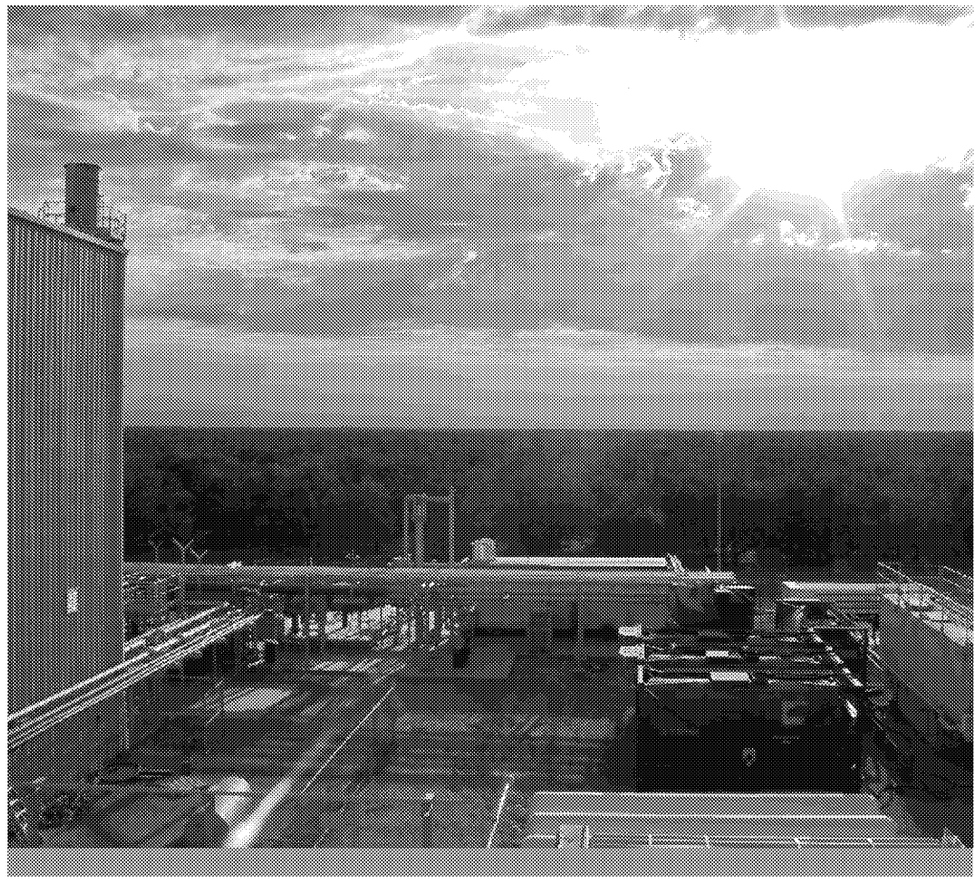


Map Courtesy of WESTCARB

CNE | COMMUNITY BENEFITS

CLEAN ENERGY SYSTEMS

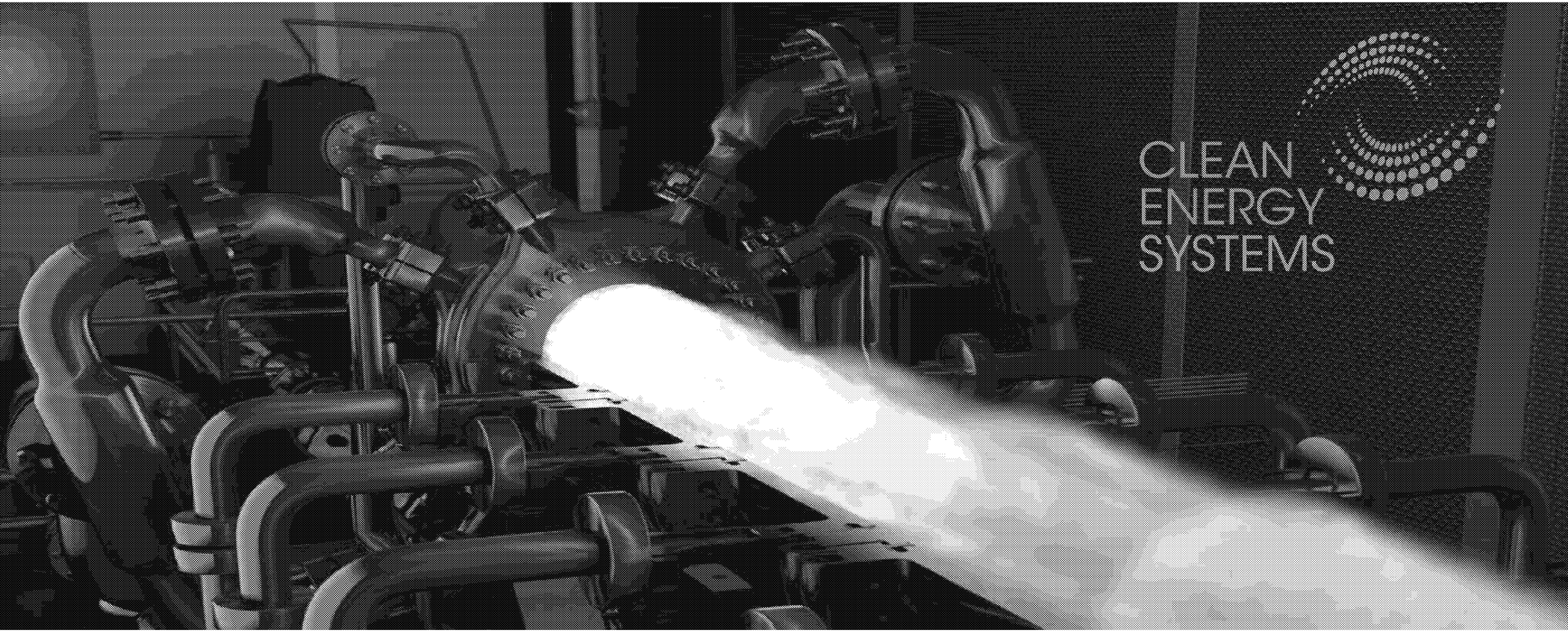
- Revitalization of existing biomass plants, supporting economic growth and jobs
- Elimination of criteria pollutant and CO_2 greenhouse gas emissions – improving local air quality
- Reduction and possible elimination of open field burning of agricultural wastes – solving waste management issues
- Decarbonization of the California transportation sector
  - Electricity or hydrogen from CNE plants removes ~3 lbs of CO_2 from the atmosphere for every mile driven
- Helps address tree mortality and wild fire crisis in the state
- Absolute necessity to meet the world's goal of less than 2 °C global temperature rise



CNE I SUMMARY & NEXT STEPS

CLEAN ENERGY SYSTEMS

- CES Carbon Negative Energy (CNE) plants have the potential to generate renewable power and/or fuels (RH_2, RNG) while effectively removing millions of tons of CO_2 from the atmosphere
  - Plants can be replicated, scaled, and configured to suit specific site needs
- CES plans to develop a portfolio of CNE plants across California making use of currently idled biomass facilities; revitalizing valuable assets and improving the state's air quality
- CES is in the project development stages of its first CNE plant at its Kimberlina facility in Bakersfield, including securing feed and offtake agreements, kicking off permitting activities, etc.
- Next steps include:
  - Continue to explore best options for Placerita Power Plant prior to initiating project development
  - Identify, locate, and secure additional sites for CNE plants



For more information, please contact CES' Business Development team:

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